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Survey of Permian Conodonts in Western North America

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ABSTRACT.—Permian conodonts are not well known but thirteen species of nine genera, including new species of *Gondolella, Subbryantodus,* and *Apatognathus* are here described. The most abundant and best preserved faunas are from the Leonardian (Artinskian-Kungurian) Bone Springs Formation of west Texas and from the Wordian Meade Peak Member of the Phosphoria Formation in Idaho and Wyoming.

Supposed Wordian (Ufimian) species are known from more than a dozen localities in the western states and at least one locality in Europe. The occurrence of conspecific forms in Wordian equivalents throughout western North America suggests useful biostratigraphic value for Permian conodonts.

The associations found in the Bone Springs and certain Phosphoria collections are suggestive of assemblages.

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TEXT

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INTRODUCTION

During the last five years there has been accomplished considerable micropaleontological work on rocks of Permian age in the western United States and Mexico but few conodonts have been secured. The scarcity of conodonts in Permian rocks throughout the world is recognized and the best taxonomic report presently available for Permian conodonts includes descriptions of three species (Youngquist, Hawley, & Miller, 1951).

PREVIOUS WORK

In their 1951 paper, Youngquist, Hawley, & Miller, traced the history of Permian conodont studies through 1951. Since that time there have been several references to Permian conodonts but only a single new taxonomic description.

McMillan (1956), Hattin (1951), Lane (1958), and Verville (1958), have indicated the presence of conodonts in the Lower Permian of Kansas. Williams (1953) mentioned conodonts from the Wolfcamp of west Texas. Thompson & Kottlowski (1955) have indicated their presence in New Mexico, Bergquist (1960) in Alaska, and Müller (1956; 1962) and Malzahn (1957) have indicated the presence of conodonts in the Permian of Europe. Ching (1960) has described eleven species, seven of them new, from the Kufeng of China. Unfortunately, most of these reports have been based on only a few specimens.

More important for this report is the fauna reported by Branson & Branson (1941) from several localities of the Phosphoria Formation in Wyoming. The fauna is in the collections of the University of Missouri and consists of specimens collected from the Meade Peak Member of the Phosphoria Formation. Most of the collection is labeled "Pustula" member of the Phosphoria in reference to the terminology of Branson (1930). McKelvey *et al.* (1959) have indicated that all of Branson's material is from the Meade Peak Member, as presently recognized. All of the Phosphoria conodonts known are probably early or medial Wordian.

PRESENT WORK

Commencing in 1956, the writers have sampled Permian rocks in western United States and Mexico in an attempt to discover additional conodonts. The results, still of a preliminary nature, are the basis of this report.

W. M. Furnish, State University of Iowa, has helped in many ways. A grant from the National Science Foundation permitted completion of this study.

PERMIAN CONODONT LOCALITIES

Each locality described is given a number which is that referred to on Text-fig. 1 and Table 1.

Texas.—Conodonts have been obtained from the Bone Springs Formation (Leonardian) and Word Formation (Wordian) in west Texas. The best Permian fauna known to the writers was obtained from the Bone Springs Formation just north of the pipeline where it enters the first canyon north of the Williams Ranch road, Culberson County, Texas (locality 1). A few specimens have been obtained from the Word Limestone which crops out on the third limestone hill east of the junction of the road and Gilliland Canyon, Glass Mountains, Brewster County, Texas (locality 2).

New Mexico.—The writers have well-preserved specimens of *Streptognathodus sulcoplicatus* Youngquist, Hawley, & Miller, from the San Andres Limestone (Wordian ?) in northwestern New Mexico (locality 3). This locality is described as Stop number 4, on the second day of the 10th Field Conference of the New Mexico Geological Society, about six and one quarter miles south of Wingate Station (*ed.*, Weir, J. E., Jr., & Baltz, E. H., 1959, p. 34).

Arizona.—Extensive collecting in the Arizona Permian has been largely unsuccessful but several specimens have been obtained from outcrops (Wordian ?) on the west side of U.S. Highway 80, about six miles south of Tombstone, T. 20 S., R. 23 E. (locality 4).

Idaho-Wyoming.—The conodonts described by Youngquist, Hawley, & Miller (1951) were obtained from the Meade Peak Member of the Phosphoria Formation from outcrops in southeastern Idaho (locality 5). Conodonts have been collected from these localities by the present writers, and, in addition, different faunas have been obtained from the Meade Peak at other localities in the immediate area as well as from the same stratigraphic unit in western Wyoming. One fauna, associated with *Helicoprion* in the Meade Peak phosphate workings, just north of Montpelier, Idaho, has been of particular value in this study (locality 6).

The Wyoming locality most productive for the present study is in Coal Canyon, Section 7, T. 26 N., R. 119 W., Lincoln County, Wyoming, on the

west side of the Sublette Mountains (locality 7). The phosphatic shale at this locality, and at others in the area, has been described in detail by McKelvey *et al.* (1953).

The conodonts collected by Branson some 30 years ago and first reported in 1941 (Branson & Branson, 1941), are from seven localities in western and west-central Wyoming. They are as follows: Bull Lake, Wyoming (locality 8); six miles southwest of Lander, Section 8, T. 32 N., R. 100 W., (locality 9); Grovont, Wyoming (locality 10); Dinwoody Creek, Wyoming (locality 11); North Fork, Popo Agie River (locality 12); Middle Fork, Popo Agie River (locality 13); Big Popo Agie River (locality 14).

All of these localities are in the Meade Peak Member of the Phosphoria Formation which has recently been referred to the Wordian (Dunbar, *et al.*, 1960), but which may be late Leonardian (Miller, Furnish, & Clark, 1957).

TEXT-FIGURE 1.—Index and locality map of Permian conodonts in North America.

Pennington (1947, University of Missouri, M.S. Thesis) collected a few specimens from the Minnekhata Limestone, on the east flank of the Laramie Mountains, NE¼, Section 18, T. 28 N., R. 70 W., Wyoming (locality 15). These specimens are described here.

Mexico.—During the summer of 1956, the senior writer participated in a project sponsored by W. M. Furnish, State University of Iowa, to study the Permian section in the Las Delicias area of Coahuila, Mexico. This locality has most recently been described by Newell (1957). It is designated locality 16 for this report. Only a few specimens from a single sample were obtained from extensive samples taken. The specimens are of special importance, however, as they occurred with *Waagenoceras* (Wordian) and are the same species found in the Wordian of Wyoming and Sicily (Müller, 1962).

Other Permian localities.—The widespread outcrops of Permian rock in Utah and eastern Nevada are fossiliferous and commonly contain microfossils. At the present time the writers are engaged in systematic sampling of these eastern Great Basin stratigraphic units.

BIOSTRATIGRAPHY

The known distribution of Permian conodonts is summarized on Table 1. The writers have followed Dunbar *et al.* (1960) in age determination for the Permian stratigraphic units. All of the formations except the Bone Springs which have yielded conodonts may be Wordian (early Guadalupian). The same species characterize each of the Wordian units and there are differences between it and the older Leonardian fauna. Because only a single definite Leonardian fauna (Bone Springs) has been described, the differences between it and the supposed Wordian faunas are not too important.

Gondolella mombergensis Tatge, first described from the Triassic, has been reported by Müller (1962) as occurring in the Sosio (Wordian) rocks of Sicily. This same species has been found in the *Waagenoceras* rocks of Mexico and fragments in the Meade Peak Member of the Phosphoria are probably conspecific.

FAUNAS

One noteworthy aspect of the Permian conodont faunas is the occurrence of a large number of a few kinds of species, together. This occurrence—especially in the Bone Springs fauna and in the *Helicoprion* material from Idaho—is suggestive of an assemblage, i.e., all of the conodont elements of many individuals of a single species of the conodont animal.

The Bone Springs material contains several hundred specimens of *Gondolella serrata* n. sp., about 30 *Subbryantodus abstractus* n. sp., about 20 *Apatognathus tribulosus* n. sp., and only a few lonchodinids, spathognathodids, and hibbardellids. This was in a single sample. All stages of ontogeny are represented in the collections and the distribution of elements within this group may represent a natural assemblage.

The fauna associated with a single *Helicoprion* sample contains no *Gondolella* elements but does contain numerous *Streptognathodus*, a genus not present in the Bone Springs material which had numerous *Gondolella*. The only collection examined which contains both *Streptognathodus* and *Gondolella* is the same as that obtained by Youngquist, Hawley, & Miller (1951) from the Meade Peak in southeastern Idaho. All of this material is broken and some

TABLE 1.—Distribution of Permian conodonts in North America. Numbers refer to localities described in text. Locality 1 is Leonardian, all others are Wordian.

SPECIES	LOCALITIES															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Apatognathus tribulosus n. sp.	X						X									
Gondolella gracilis n. sp.							X			X						
Gondolella idahoensis Y, H, M					X			X	X		X	X	X	X		
Gondolella mombergensis Tatge																X
Gondolella phosphoriensis Y, H, M					X			X	X		X	X	X	X		
Gondolella serrata n. sp.	X				X	X	X	X	X		X		X			X
Hibbardella spp.	X						X									
Hindeodella spp.		X			X	X	X				X			X		
Lambdagnathus sp.							X									
Lonchodina mülleri Tatge	X					X	X									
Spathognathodus n.sp.	X														X	
Streptognathodus sulcolplicatus Y, H, M			X		X	X										
Subbryantodus abstractus n. sp.	X			X			X				X		X	X		

mixing may have occurred. The only difference between the *Helicoprion* associated species and the fauna of the Bone Springs is the presence of species of *Gondolella* in the latter and of *Streptognathodus* in the former.

SYSTEMATIC PALEONTOLOGY

Repository designations are as follows: BYU—Department of Geology, Brigham Young University, Provo, Utah; UM, Department of Geology, University of Missouri, Columbia.

Genus APATOGNATHUS Branson & Mehl, 1934

Apatognathus tribulosus n. sp.
pl. 1, figs. 3, 7, 13, 17

Strongly arched, strongly bowed species with large apical denticle and two limbs which are sub-parallel, equal-length, but denticles of one are always more numerous and larger than denticles of other. Denticles laterally-compressed and range from 5-9 on one limb, 3-6 on the other. Both sinistral and dextral.

Basal edge sharp, basal cavity minute but some specimens have an expanded base beneath the apical denticle.

Remarks.—Of the various species which have been referred to *Apatognathus* (*A. varians* Branson & Mehl, *A. inversus* Sannemann, *A. lipperti* Bischoff, *A. ziegleri* Diebel, *A. logidentatus* Tatge = *A. ziegleri*) only the type seems to be properly classified. All others probably should be placed in a different genus.

A. tribulosus n. sp. is most similar to *A. ziegleri* Diebel but it differs because the limbs are always well developed and sub-parallel and the denticles are very delicate, laterally-compressed, not oval. The Devonian and Mississippian species do not have similar denticles, arching, or gross form. Present collections consist of about 20 specimens from two localities. *Lonchodina lungtanenis* Ching may be an *Apatognathus*.

Occurrence.—Bone Springs Formation, Leonardian, west Texas; Meade Peak Member of the Phosphoria Formation, Wordian, Coal Canyon, western Wyoming.

Repository.—BYU 454 (holotype), 455, 456, 457.

Genus GONDOLELLA Stauffer & Plummer, 1932

There have been 30 species of *Gondolella* proposed previous to this report. Ellison (1941) recognized five junior synonyms among this group, Branson & Mehl (1938) recognized that *G. nodosa* was an *Icriodus,* Huckriede (1958) proposed that *G. haslachensis* Tatge = *G. mombergensis* Tatge, and it appears that *G. prima* Elias is most likely a bar-blade type conodont. If these determinations are valid, there are 22 species of *Gondolella* previously described with a range of Middle Pennsylvanian through Upper Triassic, twelve in the Pennsylvanian, three in the Permian, and seven in the Triassic. Two new Permian species are here described.

G. denuda Ellison may range from Pennsylvanian to Lower Triassic (Clark, 1959) and Müller (1962) indicated a Permian to Triassic range for *G. mombergensis* Tatge, a fact confirmed in this study.

Gondolella gracilis n. sp.
pl. 1, fig. 12; pl. 2, figs. 6, 10

Long extremely narrow platform which tapers gradually toward anterior end of carina at which point the platform is extremely narrow. During ontogeny, platform increases in width only gradually; on early stages, anterior end of carina extends beyond platform but at maturity, carina and platform are of equal length. Platform margins slightly up-turned, smooth surface. Carina consists of 12-18 denticles averaging about 14. The posterior-most denticle is distinctly directed posteriorly and is 3-4 times as large as any other denticle of carina.

High keel present on anterior third of lower surface. This merges with a long slender loop which encircles a small pit. Pit located at posterior end. Crimp broad. Basal attachment material common, forming high long walls on lower surface.

Remarks.—Several dozen specimens of this species have been obtained. All possess an

extremely narrow platform and an unusually large posterior denticle. These features distinguish the species from all others. It occurs with *G. serrata* n. sp. in the Phosphoria but has not been found with this species in the west Texas material.
Occurrence.—Meade Peak Member of the Phosphoria Formation, Wordian, Coal Canyon and Grovont, Wyoming.
Repository.—BYU 468, UM C978-4, C978-5 (holotype).

Gondolella idahoensis Youngquist, Hawley, & Miller
pl. 2, figs. 15-16

Gondolella idahoensis YOUNGQUIST, HAWLEY, & MILLER, 1951, Jour. Paleontology, v. 25, p. 361, pl. 54, figs. 1-3, 14, 15; CLARK, 1959, *ibid.*, v. 33, p. 308.

Numerous individuals of this species are present in the Phosphoria collections of southern Idaho and Wyoming. It differs from *G. phosphoriensis* Youngquist, Hawley, & Miller, with which it occurs, principally in the possession of a discrete carina.
Occurrence.—Meade Peak Member of the Phosphoria Formation, Wordian, southern Idaho, Wyoming.
Repository.—BYU 474, 475.

Gondolella mombergensis Tatge
pl. 1, fig. 14

Gondolella mombergensis TATGE, 1956, Paläont. Zeit., b. 30, p. 132, t. 6, figs. 1-2; HUCKRIEDE, 1958, *ibid.*, b. 32, p. 147, t. 10, figs. 26, 27, 29a,b,c, 30, 42, 43, 45a,b; CLARK, 1959, Jour. Paleontology, v. 33, p. 309.
Gondolella haslachensis TATGE, 1956, Paläont. Zeit., b. 30, p. 131-132, t. 6, figs, 3a, b, c;HUCKRIEDE, 1958, *ibid.*, b. 32, p. 147; CLARK, 1959, Jour. Paleontology, v. 33, p. 308.

This species, originally described from the upper Muschelkalk, has recently been noted in Middle Permian of Sicily (Müller, 1956; 1962). A single, well-preserved specimen from the *Waagenoceras* beds of Coahuila, Mexico, is apparently conspecific. The unsculptured platform and partially fused carina are the principal characteristics of this species.
Occurrence.—*Waagenoceras* limestone, Wordian, Las Delicias, Coahuila, Mexico.
Repository.—BYU 449.

Gondolella phosphoriensis Youngquist, Hawley, & Miller
pl. 2, figs. 17-18

Gondolella phosphoriensis YOUNGQUIST, HAWLEY, & MILLER, 1951, Jour. Paleontology, v. 25, p. 362, pl. 54, figs. 10-12, 27, 28; CLARK, 1959, *ibid.*, v. 33, p. 308.

Youngquist, Hawley, & Miller (1951) separated this species from *G. idahoensis* because "the lateral zones of the platform are thickened, and the posterior portion of the carina is ridge-like rather than discretely nodose (p. 362)." All of the type material was broken but in the extensive material now available from Idaho and Wyoming there are complete and well-preserved specimens.

The fact that during the ontogeny of *G. serrata* n. sp., there is a fusion and reduction of the carina and also a thickening of the platform margins, suggests that *G. phosphoriensis* may be a growth stage (gerontic) of *G. idahoensis*. Plate 2, figures 15 and 16 show the carina reduction and fusion of this species.
Occurrence.—Meade Peak Member of the Phosphoria Formation, Wordian, southern Idaho and Wyoming.
Repository.—UM C978-2, C978-3.

Gondolella serrata n. sp.
pl. 1, figs. 10-11, 15, 19; pl. 2, figs. 1, 5, 8-9, 11-14

Gondolella sp. YOUNGQUIST, HAWLEY, & MILLER, 1951, Jour. Paleontology, v. 25, pl. 54, fig. 20.

During ontogeny, shape changes from very narrow anteriorly-tapering platform with

carina extending beyond anterior-most part of platform, to platform which is wider and quite flat at posterior end and also as long as carina. Margins of platform upturned to greater degree in young forms than after maturity at which time there is only a small depression between carina and platform and platform is flat on posterior portion.

Platform ornamentation smooth to granular during all ontogenetic stages on posterior portion, but anterior half develops transverse ridges during ontogeny. These ridges are weak to strong but on most of the specimens the anterior edges also become serrate corresponding with the ridges. Ridges do not extend to carina on all specimens. Older specimens are not so strongly ridged as younger forms.

Denticles of carina discrete, between 14-18 in number, averaging 16 at maturity. The anterior-most 4-5 are the highest; the denticles are moderately sized and at the posterior end, one or two larger sized denticles are present at maturity. These two may occur as a fused single denticle. On larger sized individuals, most of the carina is commonly fused.

Keel of lower surface is high and sharp on anterior portion but it merges with long broad shallow loop which encircles pit. Pit is located at posterior end. The loop and pit are higher at the posterior end than elsewhere. Crimp is broad. Basal attachment material common. This forms a high deep-sided basin which conforms to the loop on the lower surface.

Remarks.—*Gondolella serrata* n. sp. is one of six known Permian *Gondolella* species. It differs from all known Permian species by the presence of an anterior serrate margin which corresponds with anterior ridges. There are several Pennsylvanian species which have similar characteristics but no other species has the particular combination of carina, serrate anterior, and gross shape, that is characteristic of *G. serrata* n. sp. *Gondolella nankingensis* Ching has ridges on all parts of the upper surface, no serrate margin, and is strongly bowed.

The basal attachment material which is present on many of the several hundred specimens of this species (pl. 2, figs. 11, 12) is unique. The material has a different texture than the conodonts and forms a deep hollow structure which is different than attachment material which has previously been reported, e.g., *Palmatolepis.*

Occurrence.—Well-preserved specimens have been obtained from the Bone Springs Formation, Leonardian, west Texas. A broken anterior end of a single specimen from the *Waagenoceras* limestone beds, Wordian, of Las Delicias, Coahuila, Mexico, appears to be conspecific. Many specimens have been collected from the Meade Peak Member of the Phosphoria Formation, Wordian, in Wyoming.

Repository.—BYU 437-448, holotype is BYU 440.

Genus HIBBARDELLA Bassler, 1925

Hibbardella spp.

Several broken specimens from the west Texas Permian and the Phosphoria Formation of Wyoming belong to the Hibbardellinae. A few have the normal long posterior limb but one has an inclination which is reversed in comparison with what is the average condition. This could possibly be a broken *Avignathus,* but this genus is known only from the Upper Devonian.

Occurrence.—Bone Springs Formation, Leonardian, west Texas; Meade Park Member, Phosphoria Formation, Wordian, Coal Canyon, Wyoming.

Repository.—BYU 871, 872.

Genus HINDEODELLA Bassler, 1925

Hindeodella spp.

pl. 1, figs. 1-2

The hindeodellid elements of the Permian conodont animals are similar to those elements described from the Paleozoic and Triassic. The elements figured are very similar to those described by Rexroad (1957, pl. 3).

One interesting note is the absence of any hindeodellid elements in the well-preserved and abundant Bone Springs material.

Occurrence.—Word Limestone, west Texas; Meade Park Member, Phosphoria Formation, Wyoming and Idaho.

Repository.—BYU 464, 466.

Genus LAMBDAGNATHUS Rexroad, 1958

Lambdagnathus sp.
pl. 1, fig. 22

A single specimen with two complete and one broken limbs is assigned to *Lambdagnathus*. Only a single species of this genus has been described and it is from the Upper Mississippian of Illinois. The type is somewhat different than the single specimen in the Permian collections.

Posterior limb consists of two large and several smaller denticles. This limb meets the two others at angles of about 90 degrees and 150 degrees. The limb which converges at 150 degrees is broken but apparently was deflected downward. Alternating large and small discrete denticles are present on all three limbs. Lower surface is grooved throughout its length and junction of limbs is only slightly more excavated.
Occurrence.—Meade Peak Member, Phosphoria Formation, Wordian, associated with *Helicoprion,* Idaho.
Repository.—BYU 564.

Genus LONCHODINA Bassler, 1925

Lonchodina mülleri Tatge
pl. 1, fig. 4

Hibbardella subsymmetrica MULLER, 1956, Jour. Paleontology, v. 30, p. 825-826, pl. 96, fig. 11 (Homonym of *Lonchodina subsymmetrica* Ulrich and Bassler, 1926).
Lonchodina mülleri TATGE, 1956, Paläont. Zeit., b. 30, p. 133, t. 5, fig. 15a,b; HUCKRIEDE, 1958, *ibid.*, b. 32, p. 151-152, t. 10, fig. 9, 16, 17; t. 11, fig. 8, 9; t. 12, fig. 28a,b, 29; t. 14, fig. 9, 33a,b, 36.
Metalonchodina digitoformis TATGE, 1956, *ibid.*, b. 30, p. 136-137, t. 6, fig. 7.
Ligonodina sp. B TATGE, 1956, *ibid.*, p. 133, t. 6, fig. 16.
Prioniodina bulbosa TATGE, 1956, *ibid.*, p. 141-142, t. 5, fig. 17.

The writers are following Huckriede (1958) in recognizing a number of synonyms of Tatge (1956).

This species possesses wide variability but in general is characterized by an asymmetrical blade with the denticles of one limb much better developed than those of the other. The main cusp has a flared apron on the inner side of the specimens. Sinistral and dextral specimens are present in the Permian material.

EXPLANATION OF PLATE 1
all photographs x40

FIG. 1, 2.—*Hindeodella* spp., BYU 464, 466, Phosphoria Formation, Wyoming.

FIG. 3, 7, 13, 17.—*Apatognathus tribulosus* n. sp., BYU 455, 456, 457, 454 (holotype). Bone Springs Formation, Texas.

FIG. 4.—*Lonchodina mülleri* Tatge, BYU 461. Bone Springs Formation, Texas.

FIG. 5, 6.—*Spathognathodus* n. sp., BYU 471, 472. Bone Springs Formation, Texas; 5, basal, 6, lateral.

FIG. 8, 9, 18.—*Streptognathodus sulcoplicatus* Youngquist, Hawley, & Miller, BYU 462, 459, 463. Phosphoria Formation, Wyoming; 8, lateral, 9, upper, 18, basal.

FIG. 10, 11, 15, 19.—*Gondolella serrata* n. sp., BYU 448, 447, 442, 441. Bone Springs Formation, Texas; 10, lateral, 11, 19, upper, 15, basal.

FIG. 12.—*Gondolella gracilis* n. sp., BYU 468. Phosphoria Formation, Wyoming.

FIG. 14.—*Gondolella mombergensis* Tatge, BYU 449. *Waagenoceras* limestones, Las Delicias, Mexico.

FIG. 16, 20, 21.—*Subbryantodus abstractus* n. sp., BYU 452, 453 (holotype), 450. Bone Springs Formation, Texas, and Phosphoria Formation, Idaho.

FIG. 22.—*Lambdagnathus* sp., BYU 465, Phosphoria Formation, Wyoming.

PLATE 1

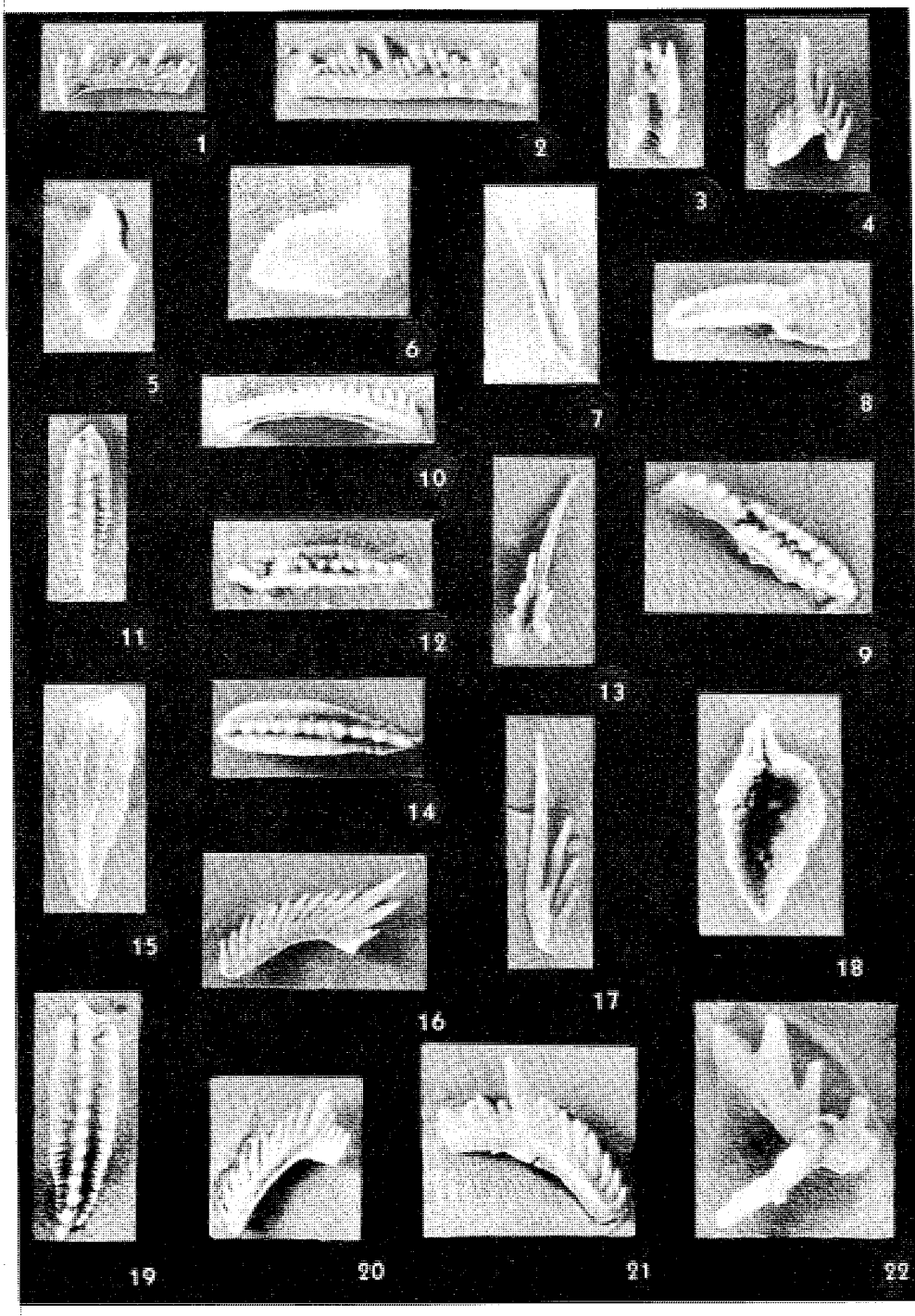
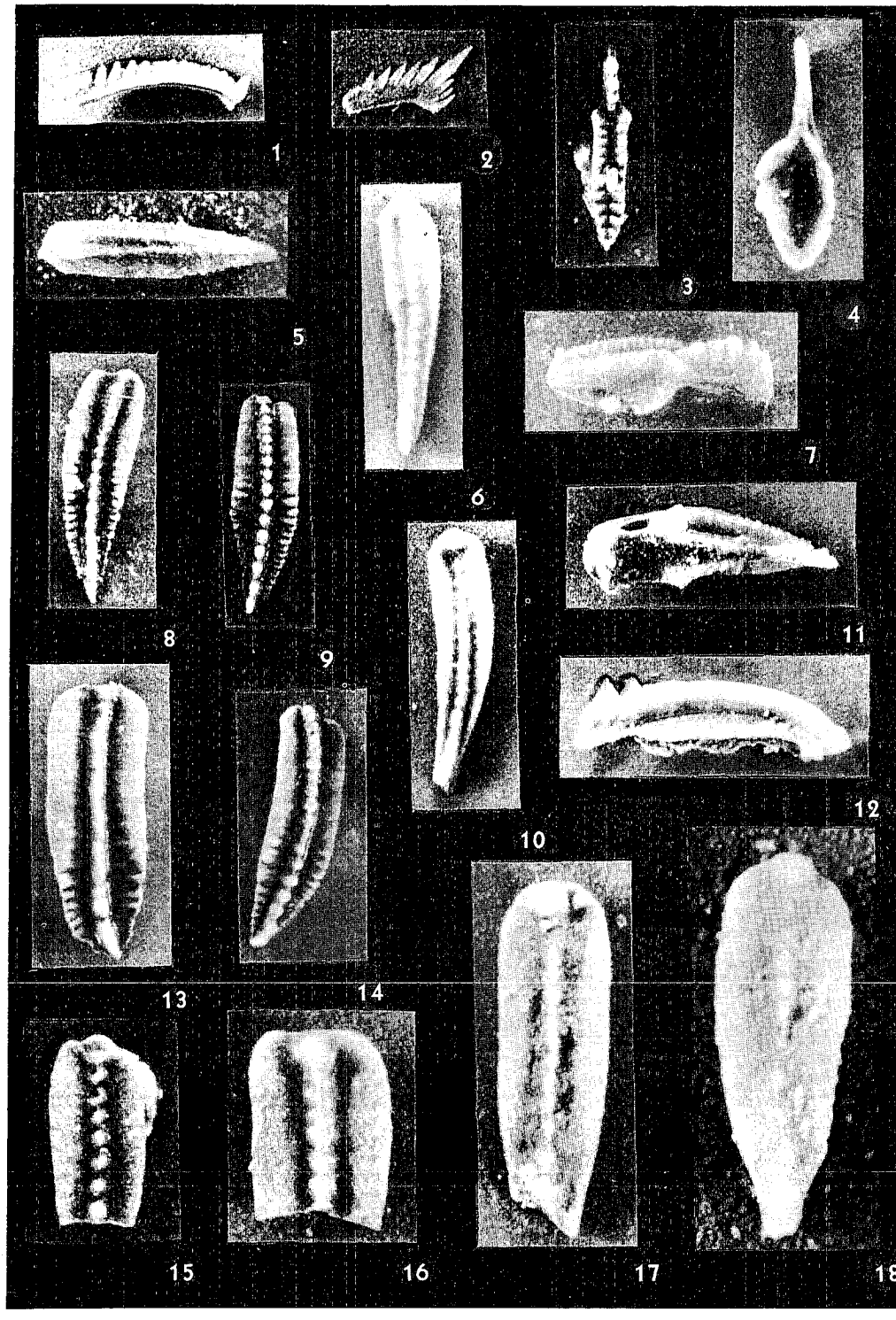


PLATE 2



Occurrence.—Bone Springs Formation, Leonardian, west Texas; Meade Peak Member, Phosphoria Formation, Wordian, Coal Canyon, Wyoming and Idaho.
Repository.—BYU 461.

Genus SPATHOGNATHODUS Branson and Mehl, 1941

Spathognathodus n. sp.
pl. 1, figs. 5-6

Small form which consists of expanded basal cavity with a small carina on the upper surface. Carina consists of about 12 denticles which are discrete only on the pointed ends and which decrease in size from the anterior end. Anterior denticle is about twice as large as others and it forms the anterior end of the specimen. It is the only denticle of the carina which is not situated completely above the basal cavity. Basal cavity extends beyond posterior margin of carina. Denticles of carina are laterally-compressed.

Remarks.—This species can be characterized by describing it as a basal cavity with a carina on the upper surface. Except for the anterior denticle, the carina is about one-half as high as the expanded flaring cavity is deep. This species may be an end member in the tendency for development of the basal cavity and reduction of the upper surface features.

The species is most closely related to *S. cristula* Youngquist & Miller and *S. minutes* Ellison, but the basal cavity is much larger at earlier growth stages. Also, the basal cavity of the species is unmodified.
Occurrence.—Bone Springs Formation, Leonardian, west Texas; Minnekhata Limestone, Wordian, Wyoming.
Repository.—BYU 471, 472.

Genus STREPTOGNATHODUS Stauffer & Plummer, 1932

Ellison (1941) considered more than one-half of all described species of *Streptognathodus* as junior synonyms. The valid species range from the Late Mississippian into the Permian.

Recently, Rexroad (1958) has pointed out an interesting observation that *Taprognathus,* an Upper Mississippian genus, and *Streptognathodus* are homeomorphs, connected by the transitional *Cavusgnathus.*

Streptognathodus sulcoplicatus Youngquist, Hawley, & Miller
pl. 1, figs. 8, 9, 18; pl. 2, figs. 3-4, 7

Streptognathodus sulcoplicatus YOUNGQUIST, HAWLEY, & MILLER, 1951, Jour. Paleontology, v. 25, p. 363, pl. 54, figs. 7-9, 16, 17, 22-24.

EXPLANATION OF PLATE 2
all photographs x40, except 15, 16, 17, and 18, which are x65

FIG. 1, 5, 8-9, 11-14.—*Gondolella serrata* n. sp., BYU 438, 445, 443, 437, 446, 444, 439, 440 (holotype). Bone Springs Formation, Texas; 1, lateral, 5, basal, 11, 12, basal and lateral views showing basal attachment material, 13, gerontic individual.

FIG. 2.—*Subbryantodus abstractus* n. sp., BYU 451. Bone Springs Formation, Texas.

FIG. 3-4, 7.—*Streptognathodus sulcoplicatus* Youngquist, Hawley, & Miller, BYU 458, 460. Phosphoria Formation, Wyoming; 3, upper, 4, basal, 7, lateral (4 and 7 BYU 460).

FIG. 6, 10.—*Gondolella gracilis* n. sp., UM C978-4, C978-5 (holotype). Phosphoria Formation, Wyoming.

FIG. 15-16.—*Gondolella idahoensis* Youngquist, Hawley, & Miller, BYU 475, 474. Phosphoria Formation, Idaho.

FIG. 17-18.—*Gondolella phosphoriensis* Youngquist, Hawley, & Miller, UM C978-2, C978-3. Phosphoria Formation, Wyoming; both are upper views showing fusion and reduction of carina.

Straight free-blade and more or less symmetrical platform with two carinae on the upper surface which are separated by a deep groove. Carina consists of 4-14 discrete nodes which develop into small ridges which are transverse to the long axis at maturity. At maturity, ridges are still confined and do not cross the central groove. Upper surface inclined posteriorly and carinae meet at posterior tip. Wide, broad, and deep basal cavity which forms entire lower surface of platform. Blade consists of five to ten denticles, at different stages of ontogeny, which are laterally compressed and discrete only at their tips. Two or three denticles are posterior of anterior margin. These are normally the highest. Blade does not extend onto the platform but the shortest denticle is the termination of the blade at the point where the carinae originate. The first node of the carina flares outward slightly at this contact.

Remarks.—The material for this study is superior in preservation to the type material. More than 40 specimens were obtained which illustrate growth as well as variation at maturity. Youngquist, Hawley, & Miller (1951) pointed out that *S. sulcoplicatus* differed from all other species by the presence of a deeper groove and that the absence of continuation of the blade on the platform was also distinctive.

S. primus Elias is similar to *S. sulcoplicatus* in these features. *S. gracilis* Stauffer & Plummer is somewhat similar in the nature of the anterior-most position of the two lateral carinae.

Occurrence.—This species has previously been reported only from the Meade Peak Member of the Phosphoria Formation, Wordian, in Idaho. Material for this study is from this same stratigraphic unit associated with *Helicoprion* in Idaho and from the San Andres Limestone, Wordian, in New Mexico.

Repository.—BYU 458, 459, 460, 462, 463.

Genus SUBBRYANTODUS Branson & Mehl, 1934

The Bone Springs material contains about 30 specimens of a new species which is difficult to assign generically. The validity of *Prioniodina, Ozarkodina, Synprioniodina, Euprioniodina,* and *Subbryantodus,* has been recognized by Hass (1962). The type species of these genera appear to be distinct from each other yet many species which have been assigned to these genera since the type description vary considerably from the original definition and it is difficult to resolve the present status. Branson & Mehl (1934) distinguished *Subbryantodus* from *Ozarkodina* by the curvature of the bar and the germ denticles which are characteristic of the ozarkodinids. Also, *Subbryantodus* has a split aboral edge which opens into a very small basal cavity. *Ozarkodina* is characterized by a sharp aboral edge.

These same differences, along with partially fused laterally compressed denticles, serve to distinguish *Subbryantodus* from *Prioniodina,* which has discrete denticles which are circular.

According to these distinctions, many of the specimens now assigned to the five genera in question should be placed elsewhere, e.g., Cooper, 1939; Branson, 1934. *Ozarkodina lungtanensis* Ching, *O. chengpangshanensis* Ching, and *Synprioniodina kufengensis* Ching, may be conspecific. All are distinct from *S. abstractus.*

Subbryantodus abstractus n. sp.
pl. 1, figs. 16, 20-21; pl. 2, fig. 2

Thin laterally compressed blades which are bowed inward with seven to 11 denticles on the anterior limb. This limb comprises the anterior two-thirds of the blade and is separated from a short posterior blade by a denticle which is twice the size of the others. Denticles are discrete for only the upper half of their height; lenticular in cross-section. Lower surface consists of a small basal cavity which flares on the outer side of the specimen and then continues for the length of the blade in both directions as a minute groove or split.

On some specimens the first denticle, posterior of the principal denticle, is almost as large as the principal denticle.

Remarks.—The specimens from the Bone Springs Formation are the best preserved of the material obtained. In transmitted light rejuvenation is well shown on a number of specimens. Both sinsitral and dextral specimens have been secured. *S. stipans* Rexroad is a more massive form with wider and thicker denticles. It is not as arched and has a longer posterior limb than *S. abstractus* n. sp.

Occurrence.—Bone Springs Formation, Leonardian, west Texas; Meade Peak Member, Phosphoria Formation, Wordian, Wyoming, Idaho, and Permian of Arizona.
Repository.—BYU 450, 451, 452, 453 (holotype).

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